FINAL TECHNICAL REPORT

A. Title: An Investigation of Mesoscale Variability Using Aircraft and MST Radar Data
NASA Grant: NAGW-1174

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C. Abstract of Research Objectives

The objectives of this research effort were to examine, using both GASP aircraft and MST radar data, the geographic and temporal variability of winds and temperature and the influences of the atmospheric motions associated with these fluctuations. A major interest, based on a pilot study, was the enhancement of the variances of velocity and temperature over apparent sources of gravity wave activity. This theme was pursued in a succession of studies refining the influences of topography, as well as other sources of variance enhancements, including frontal systems, convection, and wind shear. Using MST radar data, we hoped to assess the the importance of gravity wave sources from another viewpoint and examine the influences of these motions in the atmosphere at greater heights.

D. Summary of Research Results

Our efforts under this research funding proved highly successful, with a clear identification of the major sources of enhanced wave variances at small spatial scales as well as significant gravity wave effects at greater heights. Source studies using data from the Global Atmospheric Sampling Program (GASP) resulted in four publications quantifying for the first time the enhancements of wave activity over topography, convection,

and wind shear and revealed that all of these are statistically important in energizing the atmospheric motion field at greater altitudes. Especially valuable was our identification of the scales that are preferentially excited and which account for the majority of the vertical fluxes of energy and momentum within the lower and middle atmosphere. These contributions were found to be most significant at horizontal scales of ~ 20 to 100 km and provide further evidence for the need to develop effective parameterizations of such transports in large-scale circulation and climate models.

These GASP results were complemented by several efforts using MST radar data which showed an enhancement of spectral variance at large frequencies similar to that noted in the GASP horizontal wavenumber spectra over topography, assessments of the spectral characteristics of gravity waves at greater heights enabling estimates of energy fluxes and dissipation rates, and evidence of strong forcing of the mean circulation and of interactions among the gravity wave and tidal motions at mesospheric heights. Together, these efforts have substantially advanced our understanding of gravity wave sources, source variability, and their atmospheric effects and will lead to better predictive models in the future.

E Publications Resulting From This Research

Jasperson, W. H., G. D. Nastrom, and D. C. Fritts, Further study of terrain effects on the mesoscale spectrum of atmospheric fluctuations, J. Atmos. Sci., 47, 979-987, 1990.

Fritts, D. C., Gravity waves in the middle atmosphere of the southern hemisphere, Dynamics, Transport, and Photochemistry in the Middle Atmosphere of the Southern Hemisphere, A. O'Neill and C. R. Mechoso, eds., 171-189, 1990.

Flatau, P. J., I. Gultepe, G. D. Nastrom, W. R. Cotton, and A. J. Helmsfield, Cirrus cloud spectra and layers observed during the Fire and GASP projects, Proceedings, Conf. on Cloud Physics, San Francisco, July 1990.

Nastrom, G. D., and K. S. Gage, Enhanced frequency spectra of winds at the mesoscale based on radr profiler observations, Radio Sci., 25, 1039-1047, 1990.

Wang, D.-Y., and D. C. Fritts, Mesospheric momentum fluxes observed by the MST radar at Poker Flat, Alaska, J. Atmos. Sci., 47, 1512 -1521, 1990.

Wang, D.-Y., and D. C. Fritts, Evidence of gravity wave-tidal interaction observed near the summer mesopause at Poker Flat, Alaska, J. Atmos. Sci., 48, 572-583, 1990.

Fritts, D. C., and D.-Y. Wang, Doppler-shifting effects on frequency spectra of gravity waves observed near the summer mesopause at high latitude, J.Atmos. Sci., 48, 1535-1544, 1991.

Fritts, D. C., Inferences of gravity wave processes from atmospheric spectra, 'Aha Huliko'a Hawaiian Winter Workshop on Internal Gravity Waves and Mixing, 117-131, 1991.

Nastrom, G. D., and D. C. Fritts, Sources of mesoscale variability of gravity waves, I: Topographic excitation, J. Atmos. Sci., 49, 101-110, 1992.

Fritts, D. C., and G. D. Nastrom, Sources of mesoscale variability of gravity waves, II: Frontal, convective, and jet stream excitation, J. Atmos. Sci., 49, 111-127, 1992.